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I. EXECUTIVE SUMMARY

a. Project Title and Applicants

Delta Smelt Exposure to Dissolved Pesticides During Vulnerable Egg and Larval Stages

Dr. Kathryn M. Kuivila, U.S. Geological Survey

b. Project Description and Primary Biological/Ecological Objectives

This study proposes to measure dissolved pesticides in the estuary, specifically when and where Delta smelt eggs and larvae are found, to determine their exposure to these potentially-toxic contaminants. Delta smelt is an endangered species and a species of concern identified by CALFED in the San Francisco Bay Estuary. The exposure of this species to dissolved pesticides during the vulnerable egg and larval stages is completely unknown. Delta smelt spawn during late winter to early summer in the Sacramento-San Joaquin Delta and the larvae remain in the area for approximately a month before swimming out to Suisun Bay. Little, if any, pesticide concentration data is available for these areas during the time period of concern.

Water quality and monitoring is of importance for CALFED. This proposed study will also add valuable information on concentrations of pesticides in the estuary and on possible sources of these compounds. Although focused primarily on the Delta smelt habitat, the resulting data set will add a highly-relevant component to future water quality monitoring programs.

c. Approach/Tasks/Schedule

The approach of this proposed study is to determine the exposure of Delta smelt eggs and larvae to dissolved pesticides in the estuary by sampling at the location and timing of Delta smelt spawning and rearing. The primary spawning area, Cache Slough Region (figure 1) in the Delta, will be sampled during the time of spawning, based on real-time sampling information from Dale Sweetnam of California DFG. When the larval Delta smelt swim out to Suisun Bay, samples primarily will be collected near a salinity of 2 ppt (the location of maximum larval fish abundance as noted by the IEP Estuarine Ecology Team).

This project is proposed for three years with sampling each year and data analysis occurring before the next sampling period. The timing of sampling will naturally be defined by the Delta smelt spawning and exodus to Suisun Bay. Three years of sampling and analysis are requested to allow adequate comparison of pesticide concentrations during different hydrologic regimes. In addition, there appears to be a recent odd-even year pattern to the Delta smelt year-class abundance which requires a comparison of contaminant data from different years. Products for each year will include quarterly progress reports, consultations with CALFED staff and investigators, presentations at meetings and conferences, and pesticide concentration data reported on the Internet. The final report,

published before the end of the third year, will be a fact sheet summarizing and interpreting the study results for resource managers.

d. Justification for Project and Funding by CALFED

This proposed study will provide information to help CALFED address their objectives of providing good water quality and improving the quality of aquatic habitats for Delta smelt (and other larval fish in the Delta and Suisun Bay).

e. Budget Costs and Third Party Impacts

CALFED Funding Request is for \$ 590,600 over a 3-year period. Concurrently, the USGS Toxic Substances Hydrology Program will be a partner at the cost of \$ 334,000 over a 3-year period. The combined cost of these projects is \$ 924,600 over a 3-year period.

f. Applicant Qualifications

The applicant is a well-known expert in the field of transport and fate of pesticides. Dr. Kathryn M. Kuivila has been working in San Francisco Bay for over seven years and has an excellent record of interacting with resource managers and fellow scientists in the area. Her studies have contributed substantially to the current understanding of contaminants in San Francisco Bay Estuary. Dr. Kuivila is well-known in the local community for developing and conducting interdisciplinary and interagency studies, and has an international reputation in the scientific community.

g. Monitoring and Data Evaluation

Data collected by this project can be used to evaluate water quality in the Delta and Suisun Bay, and can easily be incorporated into a larger-scale monitoring program.

h. Local Support/Coordination with other Programs/Compatibility with CALFED objectives

The proposed project will coordinate with on-going studies funded by the Interagency Ecological Program, California Department of Water Resources, and California Department of Fish and Game. Specifically, we will be working closely with Dale Sweetnam of DFG, Dr. William Bennett (IEP), and Jon R. Burau (USGS funded by IEP). Coordination would also occur with several studies proposed to CALFED, including Bennet et al. (contaminant effects in Delta smelt), Schoellhamer and Dinehart (sedimentation in the Delta and Suisun Bay), and Luoma et al. (assessment of selenium contamination).

II. TITLE PAGE

a) Title of Project:

Delta Smelt Exposure to Dissolved Pesticides During Vulnerable Egg and Larval Stages

b) Principal investigator:

Dr. Kathryn M. Kuivila, USGS, 6000 J St, Sacramento, CA 95819-6129
(916) 278-3054, Fax (916) 278-3071, kkuivila@usgs.gov

c) Type of Organization: Federal agency

d) Tax identification number: 53-0196958

e) Technical and financial contact person: Same as above

f) Participants/Collaborators in Implementation : No others

g) RFP project group type: Other services

III. PROJECT DESCRIPTION

a. Project Description and Approach

1) Introduction

Delta smelt are a species of concern in the San Francisco Bay Estuary, and the pattern of their decline has fisheries biologists floundering for an explanation. Flow-related explanations are not adequate to explain their continuing pattern of decline, suggesting the importance of non-flow-related stressors, such as contaminants. Egg and larval stages of fish are typically more vulnerable to effects of contaminants. The exposure of Delta smelt to potentially-toxic dissolved pesticides during egg and larval stages is completely unknown. Biological effects of pesticides are dependent on pesticide concentration and duration of exposure. Dissolved pesticide concentrations and Delta smelt concentrations in the estuary overlap both spatially and temporally, but do not necessarily co-vary. For example, the timing and distribution of pesticide input is probably very different than the fish input. In addition, once Delta smelt larvae become motile, fish transport becomes different than pesticide transport. Therefore, rather than sampling pesticide concentrations at a fixed point or synoptically, sampling needs to measure the concentrations actually being experienced by the eggs and larval fish, i.e. "Lagrangian fish frame-of-reference".

Delta smelt spawn during late winter to early summer in the Sacramento-San Joaquin Delta. Their spawning grounds are in freshwater, downstream of the American River on the Sacramento River and Mossdale on the San Joaquin River (figure 1). The Cache Slough Region is a common spawning area in both wet and dry years. Little, if any, pesticide concentration data is available for the Cache Slough Region. In addition, only limited data is available for the majority of the Delta during spring and early summer. Approximately a month after hatching, the Delta smelt larvae become motile and head for Suisun Bay. Recent studies by the IEP Estuarine Ecology Team suggest that larval fish, including Delta smelt, remain at approximately 2 ppt salinity as the tides "slosh them back and forth" throughout Suisun Bay. Again, very limited data is available for dissolved pesticide concentrations in Suisun Bay during the summer.

Most monitoring programs sample monthly at a limited number of sites and can easily miss pulses of highly variable concentrations of pesticides. A previous USGS study (MacCoy and others, 1995) monitored the inputs of pesticides from both the Sacramento and San Joaquin Rivers on an every-other day basis for three and a half years -- that monitoring did not include the input of pesticides from the Cache Slough Region or within the Delta, and was limited to analysis of 20 compounds. (That analysis list was based purely on analytical constraints and was totally unrelated to probability of detection, use patterns, or toxicity.) Pesticides applied to rice fields in the Sacramento Valley have been of concern in recent years and have been implicated in the decline of striped bass. Although sampling for rice pesticides has typically been focused on drains and the upper reaches of the Sacramento River, elevated concentrations have been detected as far seaward as Mallard Island (see figure 1). In 1996, we collected daily samples at Mallard Island with an autosampler and analyzed for the limited suite of pesticides in the water. Elevated concentrations of the rice

pesticides (molinate, thiobencarb, and carbofuran) were present from mid-May through mid-July in a broad peak (figure 2).

Hundreds of pesticides are applied in the Central Valley with the majority of them being applied during the spring and summer growing period (California Department of Pesticide Regulation, 1994). The result is that species of concern will likely be exposed to a large number of pesticides simultaneously, not just elevated concentrations of a single compound.

2) Project Objectives

The objective of this proposed study is to measure the exposure of Delta smelt to dissolved pesticides during vulnerable egg and larval stages. Sampling will be designed to sample when and where the Delta smelt are most vulnerable, i.e. egg and larval stages. Analysis will focus on pesticides in the water, the most likely route of exposure for pesticides to these life stages. This study will identify locations and hydrologic conditions when the Delta smelt are most, and least, exposed to dissolved pesticides with the goal of aiding development of restoration strategies that minimize the species of concern's exposure to pesticides.

Questions we seek to answer include :

- What pesticides and what concentrations are Delta smelt exposed to during their egg and early larval stages (i.e. in the Delta)? How long are they exposed?
- What pesticides and what concentrations are Delta smelt exposed to during their later larval stages (i.e. at 2 ppt in Suisun Bay)? How long are they exposed?
- What are the sources and relative importance of those sources of the pesticides found at measurable or significant levels? These answers would help influence restoration strategies.
- How does this contamination affect the Delta smelt? This question could be answered with a direct link to the Bennett et al. proposed study of contaminant effects on Delta smelt.

3) Approach

Delta Smelt Spawning Period

Concentrations of dissolved pesticides will be measured in early spring in the primary spawning area in the Cache Slough Region (figure 1). Sites will be selected to differentiate between various hydrologic inputs. The timing and location of the field sampling will be coordinated with real-time

hydrologic inputs. The timing and location of the field sampling will be coordinated with real-time data from Dale Sweetnam (California Department of Fish & Game) on the location of spawning adults. Flow information (Schoellhamer and Dinehard proposal to CALFED) and short-term drogue or drifter studies will be used to determine the extent of tidal excursion and therefore, the likely range of the non-motile larvae.

Delta Smelt Larval Period

Approximately a month after spawning, the Delta smelt larvae become motile and head for Suisun Bay. At this time, the sampling would shift to Suisun Bay at an appropriate site to cover salinities between 1 and 5 ppt. Dissolved pesticide sampling will be based on salinity with most of the samples collected at 2 ppt -- salinity of maximum larval fish abundance as shown by recent IEP studies. This sampling will be coordinated with larval-fish sampling studies by the IEP Estuarine Ecology Team and continued input from Dale Sweetnam (DFG).

b) Location and/or geographic boundaries of project

Study area encompasses the Delta and Suisun Bay as bounded by the Freeport on the Sacramento River, Vernalis on the San Joaquin River, and seaward to and including Carquinez Strait (Figure 1). Study sites are located in the counties of Contra Costa, Sacramento, San Joaquin, and Solano.

c) Expected Benefits

This proposed study will provide information to help CALFED address their objectives of providing good water quality and improving the quality of aquatic habitats for Delta smelt and other larval fish. This information can be used by resource managers and CALFED to identify sources of pesticides stressing the species of concern. In addition, knowledge of the mixture of pesticides and concentrations to which the Delta smelt are exposed will aid scientists looking for direct evidence of contaminant effects, such as proposed by Bennett and others to CALFED. As an indirect benefit, this study may identify changes in water quality as various ecosystem restoration projects are implemented in the Delta.

d) Background and Biological/Technical Justification

There is little or no concurrent information available on the concentrations of dissolved pesticides and Delta smelt life stages in the estuary. Previous pesticide data from limited sampling in other reaches of the Delta and during monitoring of the riverine inputs suggests that it is very likely that Delta smelt are being exposed to a large number of pesticides during a vulnerable time. The information provided by this study will be the first step in evaluating the potential effects of pesticides on Delta smelt.

The proposed study is a new project, designed for three years, but will hopefully become a significant part of a longer-term monitoring effort. The design of this proposal is built on information and knowledge of Delta smelt spawning and rearing behavior, hydrodynamics, and pesticide transport from past studies by the USGS and California DFG. The proposed study would focus specifically on Delta smelt habitat.

e) Proposed Scope of Work

Each year of this proposed three-year project includes a sampling phase, defined by the Delta smelt spawning and exodus to Suisun Bay, followed by a data analysis phase. The third year will also involve the writeup of a final report. Project results will be provided in the form of 1) quarterly progress reports, 2) consultations with CALFED staff and investigators, 3) presentations at meetings and conferences, 4) pesticide concentration data reported every year on the internet (in a similar fashion to DFG's animated 20mm Delta smelt survey results at <http://www.delta.dfg.ca.gov/data/20mm97>), and 5) a fact sheet summarizing and interpreting the study results for resource managers.

f) Monitoring and Data Evaluation

Data collected by this project can be used to evaluate water quality in the Delta and Suisun Bay. We envision this study as a significant component of future long-term water-quality monitoring efforts in the estuary. The sampling in this study will be closely coordinated with proposed studies directed at mercury cycling (Marvin-DiPasquale et al. to CALFED) and selenium effects (Luoma et al. to CALFED), expanding the mixture of contaminants USGS is proposing to assess in the Bay-Delta. It will be highly beneficial to the CALFED goal of coordinated study and monitoring of the Bay-Delta to partner in the study of all these contaminants simultaneously; these studies together can provide an unprecedented, coordinated view of the complex contaminant issues in the Bay-Delta. These coordinated studies will also continue and expand the multi-discipline cooperation and collaboration that characterize USGS studies. Project data and all written reports must be reviewed and approved by USGS technical specialists.

g) Implementability

The proposed work is implementable and technically feasible. No special permits are involved.

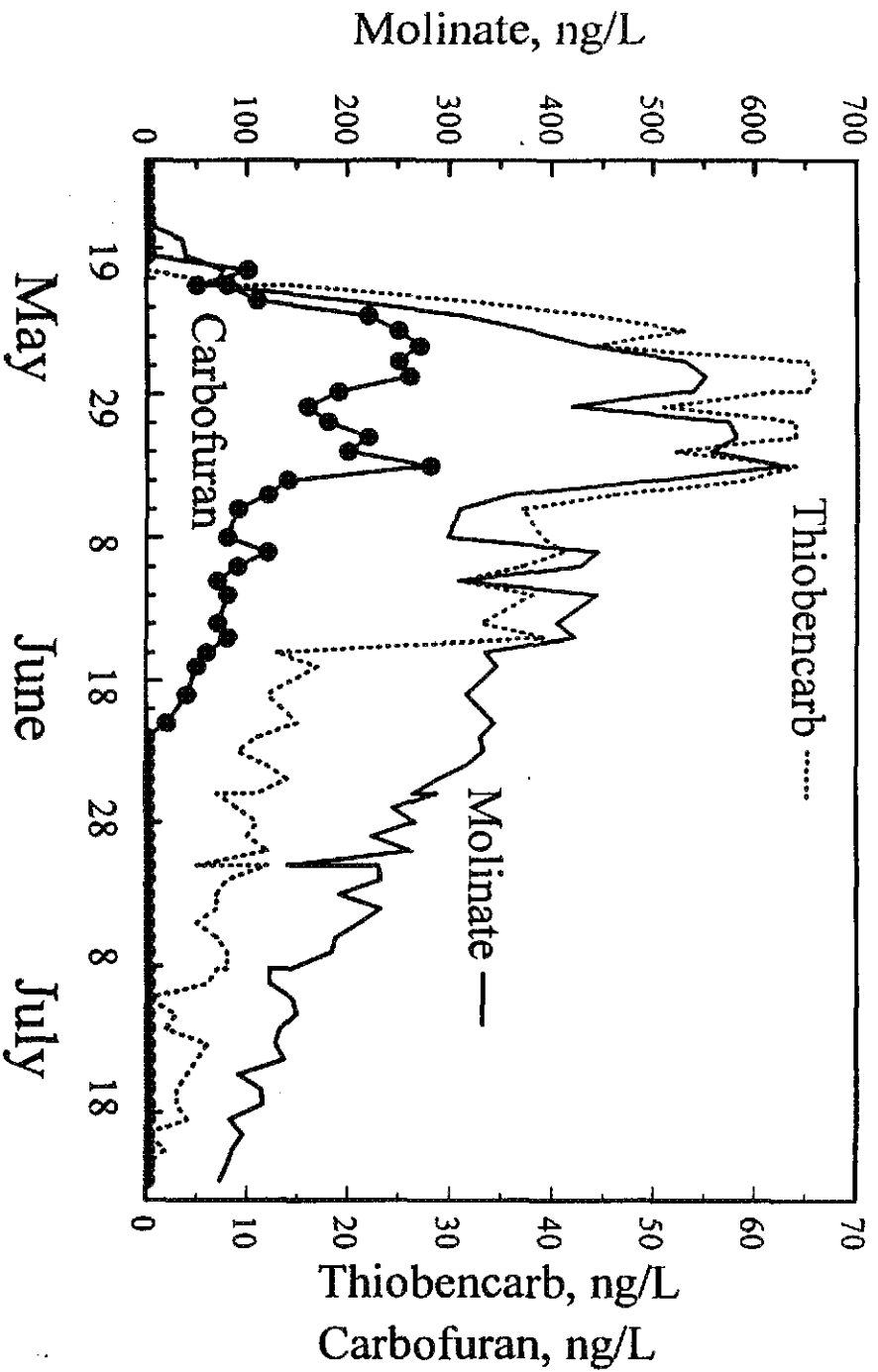


Figure 2. Rice pesticide concentrations
at Mallard Island in 1996

IV. COSTS AND SCHEDULE

a) Budget Costs

CALFED funding is being requested because this project will provide information to help CALFED address their objectives of providing good water quality and improving the quality of aquatic habitats for species of concern (Delta smelt). The CALFED funding request is for \$ 590,600 over a 3-year period in partnership with the USGS Toxic Substances Hydrology Program funding \$ 334,000 over the 3-year period. The combined cost of these projects is \$ 924,600 over the 3-year period. Cost breakdown for by year is shown in Table 1 and the CALFED request cost breakdown by task and category is shown in Table 2.

Table 1 - Budget for Total Project

	1998	1999	2000	Total
CALFED STUDY	\$ 185,800	\$ 197,000	\$ 207,800	\$ 590,600
USGS STUDY	\$ 102,800	\$ 111,600	\$ 119,600	\$ 334,000
TOTAL	\$ 288,600	\$ 308,600	\$ 327,400	\$ 924,600

Table 2 - Breakdown of CALFED Funding Request

Task	Labor hours	Salary and Benefits	Overhead	Service Contract	Material & Acq. Contract	Misc. & Other	Total Cost
Year 1 CALFED	2,860	\$ 58,200	\$ 92,900	0	0	\$ 34,700	\$ 185,800
Year 2 CALFED	2,860	\$ 63,500	\$ 98,500	0	0	\$ 35,000	\$ 197,000
Year 3 CALFED	2,860	\$ 68,700	\$ 103,900	0	0	\$ 35,200	\$ 207,800

CALFED FUNDING REQUESTED = \$ 590,600 over a 3-year period

USGS PARTNERSHIP FUNDING = \$ 334,000 over a 3-year period

TOTAL FUNDING FOR BOTH PROJECTS = \$ 924,600 over a 3-year period

b) Schedule Milestones

Sampling preparation and design will commence within 30 days of the USGS receiving a signed funding agreement. Sampling will occur every year, with the timing depending on the Delta smelt behavior. The data from each sampling year will be presented on the Internet before the end of each calendar year. The final fact sheet will be completed before the end of the third year.

c) Third Party Impacts

We know of no third party impacts of the proposed project.

V. Applicant Qualifications

The principle investigator for this project is Dr. Kathryn M. Kuivila of the U.S. Geological Survey. I am not aware of any potential conflicts of interest.

Dr. Kathryn M. Kuivila will be in charge of the project, including both sampling design and pesticide analyses. Dr. Kuivila received her Ph.D. in Chemical Oceanography from the University of Washington in 1986. She is currently employed as a research hydrologist by the Water Resources Division of the U.S. Geological Survey in the California District Office in Sacramento, California. Her primary focus of research is on the transport, degradation, and fate of organic contaminants, particularly pesticides, in the San Francisco Bay Estuary and has an international reputation in the scientific community. She has been studying pesticides in San Francisco Bay since 1990 and is well respected by the state and local resource managers in the area. Her research efforts have contributed greatly to understanding riverine pesticide inputs, transport of pesticides during high flow events, and degradation of pesticides within the estuary (see table 3). Dr. Kuivila has a strong record of collaborating with state and local agencies, including the Central Valley Regional Water Quality Control Board, California State Water Quality Control Board, Interagency Ecological Program, U.S. EPA, and California Department of Fish and Game.

Table 3 - References

California Department of Pesticide Regulation, 1994, Pesticide use data: California Department of Pesticide Regulation.

Crepeau, K.L., Domagalski, J.L., and Kuivila, K.M., 1994, Methods of analysis and quality-assurance practices of the U.S. Geological Survey Organic Laboratory, Sacramento, California -- Determination of pesticides in water by solid-phase extraction and capillary-column gas chromatography/mass spectrometry: U.S. Geological Survey Open-File Report 94-362, 17 p.

Crepeau, K.L., K.M. Kuivila, and J.L. Domagalski, 1996, Concentrations of dissolved rice pesticides in the Colusa Basin Drain and Sacramento River, California, 1990-1992, in Morganwalp, D.W., and Aronson, D.A., eds., U.S. Geological Survey Toxic Substances Hydrology Program--Proceedings of the Technical Meeting, Colorado Springs, Colorado, September 20-24, 1993: U.S. Geological Survey Water-Resources Investigations Report 94-4015, vol. 2, p. 711-718.

Domagalski, J.L. and Kuivila, K.M., 1991, Transport and transformation of dissolved rice pesticides in the Sacramento River Delta, California, in Mallard, G.E., and D.A. Aronson eds., U.S. Geological Survey Toxic Substances Hydrology Program--Proceedings of the Technical Meeting, Monterey, California, March 11-15, 1991: U.S. Geological Survey Water-Resources Investigations Report 91-4034, p. 664-666.

Kuivila, K.M., 1991, Distribution of pesticides in the Sacramento-San Joaquin Delta: U.S. Geological Survey Yearbook, Fiscal Year 1991, p. 67-70.

Kuivila, K.M. and Nichols, F.H., 1991, Overview of the San Francisco Bay Estuary Toxic Contaminants Study, in Mallard, G.E., and D.A. Aronson eds., U.S. Geological Survey Toxic Substances Hydrology Program -- Proceedings of the Technical Meeting, Monterey, California, March 11- 15, 1991: U.S. Geological Survey Water-Resources Investigations Report 91-4034, p. 659-663.

Kuivila, K.M., 1993, Diazinon concentrations in the Sacramento and San Joaquin Rivers and San Francisco Bay, California, February 1993 : U.S. Geological Survey Open-File Report 93-440, 2 p. (Water Fact Sheet)

Kuivila, K.M. and Foe, C.G., 1995, Concentrations, transport, and biological effects of dormant spray pesticides in the San Francisco Estuary, California, Environ. Toxicol. Chem., v. 14, no. 7, p. 1141-1150.

Kuivila, K.M. and Copeland, D.D., 1996, Diazinon concentrations and transport in the Sacramento River and San Francisco Bay, California, February 1993, in Morganwalp, D.W., and Aronson, D.A., eds., U.S. Geological Survey Toxic Substances Hydrology Program--Proceedings of the Technical Meeting, Colorado Springs, Colorado, September 20-24, 1993: U.S. Geological Survey Water-Resources Investigations Report 94-4015, vol. 2, p. 699-704.

Kuivila, K.M., Sheipline, R.C., and Foe, C.G., 1996, Distribution and possible biological impacts of diazinon in the San Joaquin River and the Sacramento-San Joaquin Delta, California, February 1993, in Morganwalp, D.W., and Aronson, D.A., eds., U.S. Geological Survey Toxic Substances Hydrology Program--Proceedings of the Technical Meeting, Colorado Springs, Colorado, September 20-24, 1993: U.S. Geological Survey Water-Resources Investigations Report 94-4015, vol. 2, p. 705-710.

MacCoy, D., Crepeau, K.L., and Kuivila, K.M., 1995, Dissolved pesticide data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-1994: U.S. Geological Survey Open-File Report 95-110, 27 p.

VI. Compliance with standard terms and conditions

A nondiscrimination compliance statement is included with this proposal. Public entity standard clauses will be submitted before or at signing of the final contract. Federal law prohibits Federal agencies from agreeing to the indemnify, hold harmless clause (Attachment D, item 9). The USGS is only able to sign with the following statement :

The USGS agrees to cooperate to the extent allowed by federal law, in submittal of all claims for alleged loss, injuries, or damage to persons or property arising from the acts of USGS employees, agents, subcontractors, or assigns, acting within the scope of their employment in connection with the performance of this agreement, pursuant to the Federal Tort Claims Act (28 U.S.C. &2671, et seq.).

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME

U.S. Geological Survey

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME

Michael V. Sulters

DATE EXECUTED

July 25, 1997

EXECUTED IN THE COUNTY OF

Sacramento, California

PROSPECTIVE CONTRACTOR'S SIGNATURE

R. Forghini

PROSPECTIVE CONTRACTOR'S TITLE

District Chief

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

U.S. Geological Survey